IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Applicants	:	McCARTHY, Wil SNYDER, Gary E.	Art Unit	:	2874
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Title	:	Fiber incorporating quantum dots as programmable dopants			
Docket No.	:	027-040001US			
Customer No.	:	33486			

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION OF ROBERT A. METZGER, Ph.D. PURSUANT TO 37 C.F.R. § 1.132

Sir:

I, Robert A. Metzger, of Chapel Hill, North Carolina, do hereby declare and state as follows based upon my personal knowledge:

1. My name is Robert A. Metzger. I offer the following statements with regard to U.S. patent application no. 09/964,927 entitled "Fiber Incorporating Quantum Dots As Programmable Dopants," by applicants Wil McCarthy and Gary E. Snyder. I have read the application specification, including the claims, at the request of the applicants. I have not received any compensation for this review or my comments.

2. I received a Ph.D. in Electrical Engineering in 1983 from the University of California at Los Angeles where I investigated the behavior of dopant atoms on semiconductor surfaces. After graduation I was employed at the Hughes Research Labs in Malibu, CA and at the Georgia Institute of Technology in Atlanta, GA. I believe I qualify as one who possesses ordinary skill in the areas of quantum devices, device fabrication, and quantum-material research.

3. My research has centered around the growth of thin film devices through a process called molecular beam epitaxy in which electronic and photonic devices are fabricated one atomic layer at a time. This allows for the tailoring of desired quantum mechanical properties to be incorporated in devices such as transistors, lasers, light emitting diodes, and quantum dots. I have specifically performed work fabricating indium arsenide quantum dots on gallium arsenide substrates. I have also worked with materials systems based on silicon, indium phosphide, and gallium arsenide. I have published over 100 technical papers and hold 8 patents in these areas.

4. It is the electron configuration about the nucleus of an atom that determines its electrical, optical, and chemical behavior. A quantum dot can exhibit an effective electron configuration that is different than that of the electron configuration of its constituent atoms owing to quantum effects generated by the quantum dot's small size. McCarthy and Snyder's claim that quantum dots incorporated in a fiber, or incorporated throughout a material, could alter the electrical, optical, and chemical behavior of that material is true. For example, the enhancement of laser performance through the incorporation of quantum dots was experimentally demonstrated a decade ago.

5. However, past demonstrations have relied on the intrinsic, static nature of the quantum dot to alter a material's characteristics. McCarthy and Snyder describe a new structure and methodology, wherein the electron structure of the quantum dot is actively manipulated through various means (such as wires to make electrical or photonic contact), giving them the ability to selectively tune the quantum dots over a wide range of electronic configurations, in essence creating an artificial atom with desired electronic configurations. The physics of altering the electrical, optical, and chemical behavior of quantum dots by electrical or photonic stimulation is understandable, as well as the methods they propose-including the use of a conductive path within a fiber material to alter the properties of the quantum dots.

6. The challenge of implementing the disclosed invention is not so much one of physics, but one of engineering. There are no fundamental physics barriers to the invention claimed and described in McCarthy and Snyder's application. Implementation of the engineering processes required to manufacture these fibers with control wires and the ability to connect them to quantum dots can be achieved with sufficient funding and equipment, not

outside the realm of a typical research laboratory in this field. I can think of several embodiments of the invention described in the application that could be produced in a laboratory (e.g., a Georgia Technical Institute laboratory) without undue experimentation. For example, traditional quantum dot devices, similar to the type described in U.S. patent 5,889,288 to Futatsugi (1999), along with a control wire could be lithographically produced on the surface of a flat, ribbon-shaped fiber. Devices capable of confining electrons at cryogenic temperatures would be quite simple to produce, although room-temperature devices would be smaller and would require tighter manufacturing tolerances.

7. McCarthy and Snyder's description of using a quantum dot as a programmable dopant atom eases many of the engineering constraints required for applications requiring a high density of programmable quantum dots. Because a very small quantity of dopant atoms (ranging from 1 part in 1,000 to 1 part in 1,000,000,000) are typically used in semiconductor devices to alter the bulk electrical, photonic, and chemical properties of these films, a relatively small number of quantum dots within a region of material could be used to alter the bulk behavior of the entire material. While such an experiment has yet to be conducted as far as I know, work on quantum dots within semiconductor lasers, in which the behavior of the quantum dots is influenced by the electrical voltage across the entire device has been demonstrated. The potential difference reconfigures the band structure of material within the device and that in turn alters the nature of the characteristics of the quantum dots. The arrangement described by McCarthy and Snyder wherein quantum dots in a material are electrically contacted directly in order to enhance control and extend the range of the quantum dots characteristics identifies a logical next step in the development of these devices.

I, Robert A. Metzger, being hereby warned that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of this application or any patent resulting therefrom, declare that all statements made of his own knowledge are true and all statements made on information and belief are believed to be true.

Signed at Chapel Hill, North Carolina on this 11th day of June, 2004.

Robert A. Metzger